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# XMap:
# A General Purpose Mapping Program

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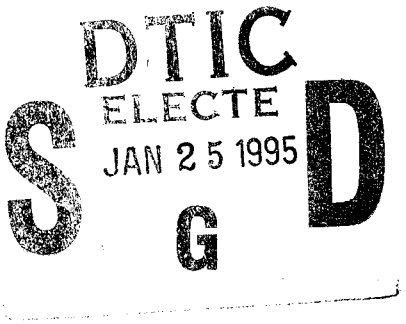

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The Military Computer Science Branch (MCSB) of the Advanced Computational and Information Sciences Directorate, Army Research Laboratory, has been developing concepts to provide enhanced information exchange on the battlefield as part of an on-going, long-term research effort known as the Information Distribution Technology (IDT). Application programs were developed to test, evaluate, and demonstrate information distribution research concepts. As the IDT matured, new application programs were needed that could more readily address the information distribution concepts. Hence, a new suite of demonstration application programs was developed. Among these applications is the program XMap, a general purpose program for displaying topographical map information and other military symbols used in planning. This report focuses on the development and execution of XMap.



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# PREFACE

The Military Computer Science Branch (MCSB) of the Advanced Computational and Informational Sciences Directorate (ACISD) of the Army Research Laboratory (ARL) has been developing concepts to exchange information acurately and timely on a dynamic battlefield. This on–going, long–term resaearch effort is known as the Information Distribution Technology (IDT). Application programs have been developed to facilitate the development, testing, refinement, and demonstration of IDT concepts. These application programs are continually changing to reflect new innovative IDT concepts. The author wishes to thank Ken Smith and Howell Caton for their contibutions in reviewing this report.

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## 1. Introduction

The Military Computer Science Branch (MCSB) of the Advanced Computational and Information Sciences Directorate, Army Research Laboratory, developed a new methodology entitled the "Information Distribution Technology (IDT)" (Chamberlain, 1990) to distribute information accurately and timely on a dynamic battlefield. The IDT has three major components: 1) an information storage database known as the Distributed FactBase (DFB) (Hartwig, 1991); 2) battlefield information contained in the form of data groupings known as facts; and 3) a battlefield communications protocol, the Fact Exchange Protocol (FEP) (Kaste, 1990), for the swift and accurate dissemination of collected information.

Several application programs were developed to facilitate the development, testing, refinement, and demonstration of the IDT concepts. Working Map (Heilman, 1991), an application program that enables the user to perform various military procedures on data stored in the DFB, provided a computer graphics representation of the battlefield. Working Map continued to be the main platform to demonstrate and test new concepts. Unfortunately, as the IDT grew, Working Map became increasingly complicated and disjointed. Errors that occurred took days and sometimes weeks to discover and fix. These problems led to the development of a new methodology for generating application programs.

This new methodology includes a general purpose program for displaying topographical map information and other military symbols used in planning. Application programs allow the user/computer to perform military procedures on the data stored in the DFB and communicate these changes to the general purpose program via a TCP/IP connection. XMap in turn, displays the result of the user/computer interaction with the DFB . The separation of these functions relieves application programs from the burden of having to display the data. An interface between specialized application programs and the map is provided via a library (LIBXMAP) (Smith and Ingham, 1994). The focus of this report is on this new general purpose program, called XMap.

## 2. XMap Overview

XMap is an X Window–based general purpose application program for displaying a topographical map and associated "overlay" objects (e.g., unit symbols, lines, areas, etc). It provides basic map manipulation functions through a user interface panel (UIP) and a set of application interface commands (AIC) to allow specialized application programs to display, select, and remove objects on the map. XMap concerns itself with the details of interfacing the window environment, relieving the application programs of that burden. In a strict sense, application programs needing to use XMap will work only in the context of the "map" – XMap will worry about the hardware/software issues of how and where to display objects on the terminal screen. XMap allows for a common map interface that can be easily shared by a number of application programs. This design facilitates the development of specialized application programs while eliminating the need to continually modify the base map display program for each new application. The AIC shown in Figure 1 uses an application program TCP/IP–based communications library. A protocol has been defined that allows for two–way communication between application programs and XMap so that both can share information synchronously and asynchronously.

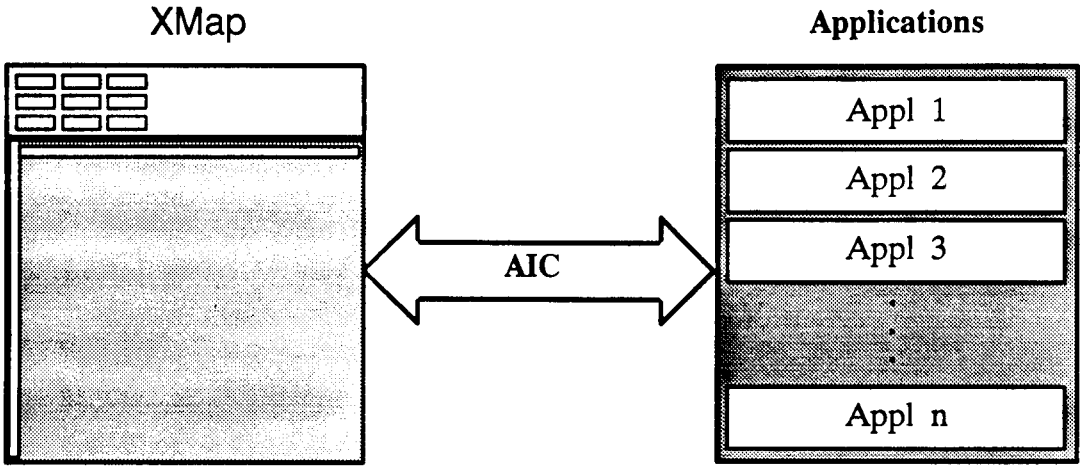


**Figure 1.** Relationship between XMap and applications.

XMap uses digitized maps (scanned images of paper maps) of strategically important areas of the world that can be underlaid on the background of the window. The maps use Universal Transverse Mercator (UTM) coordinates and all application programs using XMap must also use UTM coordinates. The UTM coordinate system divides the world up into rectangular sections, maps, and uses a spheroid model of the earth to account for curvature of the earth that occurs during transition from one map to another. This transition from one map to another is called zone–to–zone transformation. Currently, XMap does not adopt these methodologies; it assumes the world is flat and contained in one zone. Grid numbers in 1,000–m increments are displayed in the bottom and left–hand borders of the window. In addition to the grid numbers, XMap has two main pulldown menus: Map Controls and Quit. The Map Controls menu has six major buttons: draw/remove grid, pan around map, show/hide a map, refresh display, create/edit a line, and zoom in/out. These buttons permit the user to interactively manipulate the background map and overlay symbols.

### 2.1 XMap Objects

As mentioned previously, XMap displays objects. Anything displayed on the window, other than the map itself, is considered to be an object. To distinguish one object from another, a "type" field is used. This field gives the object its defining characteristics (i.e., determines what other fields need to be filled). There are eight major object types: symbol, text, point, line ,area, link, rangefan, and association. Seven of these object types can be physically represented and are shown in Figure 2.

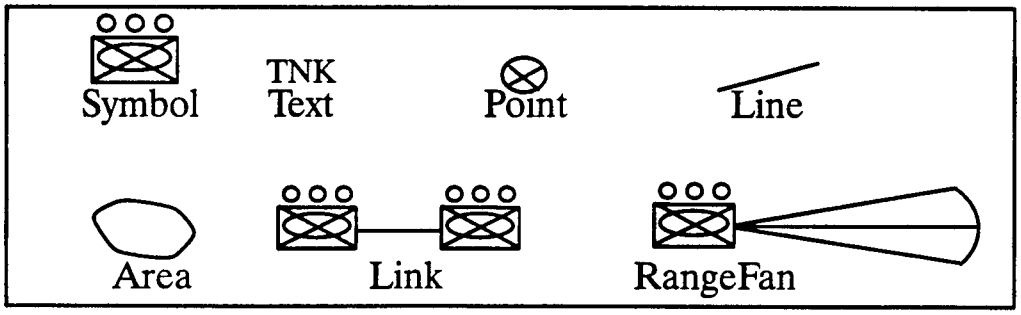


**Figure 2.** Major object types used by XMap.

A symbol is a graphical representation of military units or map overlay objects such as bridges, buildings, etc. Units (enemy and friendly), air defense air tracks, and labels are examples of symbols. XMap uses X Window XmDrawnButton widgets to display symbols. An XmDrawnButton widget is used since symbols tend to be the most numerous objects displayed and the window manager handles all of the exposure events for this widget, relieving XMap of this burden. At the time of the writing of this report, text and point object types have not been implemented as object types. The functionality of text and points has been provided through the use of symbols. These types were included with the thought that future application programs may want to distinguish labels and points from symbols.

A "line" type is nothing more than a list of segments. A segment is a pair of coordinates that identify the endpoints of a line segment.

The "area" object type was included to distinguish routes, roads, etc., from areas of influence and areas of interest. At this time, all areas are represented by a line with the end point and start point the same. Future versions of XMap should show the extensive use of object type area.

A "link" is a line with its end points being the reference points of two unit symbols, two air track symbols, or an air track and a unit symbol. This type is used primarily to show targeting information. Two additional fields are added to this type: the source object and the destination object. These fields provide the program with the capability of independently moving the line when either the source or destination object moves.

A "rangefan" depicts the area within which a unit can fire its weapons. This type has an additional field to designate the source object or the unit to which it applies. Like the fields added to the link object type, this field allows the program to move the rangefan when the source object moves.

An association type has no displayable characteristics and is used to associate one object to another. There are two possible ways to associate an object to another object. The first is a master–slave configuration. In this configuration, if the master object moves, then the slave object moves with it as if they were really one object. Conversely, movement of the slave object has no effect on the master – it does not move. An alternative configuration is the "group" association, where movement of either object affects the other as movement of the master object affected the slave object.

## 3. XMap Functional Review

XMap has two main menus: a Map Controls menu and a Quit menu. The Map Controls menu contains a submenu of functions that permit the user to interactively manipulate the map and the background. The functions associated with the Map Controls menu are: draw/remove grid, pan, show/hide map, refresh display, create/edit line, and zoom in/out. The Quit menu has a yes or no button that allows the user a chance to change his/her mind before exiting the XMap program. Figure 3 shows the layout of the display window and the main menus.

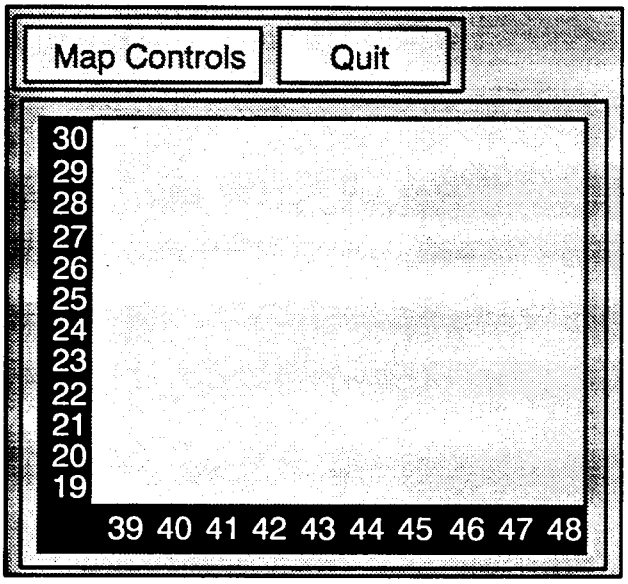


**Figure 3.** Graphical user interface for XMap

### 3.1 Draw/Remove Grid.

The grid function draws or removes horizontal and vertical grid lines at 1,000−m increments. This is helpful to the user to better determine an object's location on the map. Grid lines are drawn on the display as overlays. That is, they are drawn in only one plane of the eight−bit plane provided by the average workstation display. This technique provides the capability of erasing the grid lines without erasing any part of the display window the grid lines obscured such as the background map or other objects.

### 3.2 Pan.

The pan function allows the user to bring those areas of the map currently not on display into the display window. When the pan button is pushed, a smaller window appears in which two rectangular boxes appear. These boxes represent the map and the user's current view area. The center of the user's view area is represented by a cross hair. Clicking[1] the left mouse button allows the user to move the center of view to different areas of the map. Currently, only one map can be viewed during each session. Theoretically, panning provides the user a means of moving anywhere in the world for which scanned maps exist. UTM coordinates are currently being used as the unit of measure with no regard to conventional military map grid zones. A better unit of measure for the world would be longitude and latitude coordinates. However, the intent of XMap was not to provide a "better" map display, but to provide a means of viewing the results of users and application programs interacting with the IDT.

### 3.3 Show/Hide Map.

The show/hide map function allows the user to turn on/off the display of the background. The user has the capability of viewing or not viewing the map underlaid on the

1. A click of a mouse button is defined as a press and release of the button, where the release action triggers an event.

display window. When a map is displayed the picture becomes very "busy." That is, it becomes difficult to discern user or application–generated objects such as lines. Therefore, the user has the option of showing or hiding a map.

### 3.4 Refresh Display

Removal of objects from the display occasionally leave "ghost" images behind. The refresh display function will redraw the display eliminating the ghost images.

### 3.5 Zoom In/Out

The zoom function performs a pixel scaling permitting a more (or less) detailed view of a specific map area.

### 3.6 Create/Edit Line.

Lines may be created and changed using the create/edit line function. A line is made up of one or more contiguous line segments. When the Create Line button has been pushed, an information panel pops up to inform the user that a Create Line session is about to begin. Lines may be used to represent routes, borders, or even areas of interest.

#### 3.6.1 Create.

To create a line, the left mouse button (on a three button mouse) is used to select the starting point of the line. An "X" is displayed to show the user the point on the map where the mouse button was pushed. This point can be changed any number of times by clicking the left mouse button in another location on the map. This allows the user to carefully choose the starting point of the line. Once this point is chosen, however, it cannot be changed until the current Create Line session is over.

The next step to creating a line is to select the rest of the points that will comprise the line. To do this, the user simply clicks the middle mouse button at different locations on the map. Every click of the middle mouse button creates the next point of the line and the location of each successive click is depicted by an "X." A dashed line is automatically drawn connecting consecutive points. A user may choose to "close" a line (connect the last point to the first point) by clicking the right mouse button. This will effectively draw a line segment from the last point that was clicked with the middle button to the starting point.

Finally, the user chooses to accept the line or to cancel the entire Create Line session using the accept and cancel buttons, respectively. Accepting the created line produces a new object in the object list stored by XMap and the line generated during the Create Line session will become permanent. If a user chooses to cancel the Create Line session, the line is not saved and is erased from the display.

#### 3.6.2 Edit.

Six basic edit functions exist under the edit control menu. They are: add point, move point, remove point, move line, erase line, and select line. The basic edit menu also has an accept and cancel button that serve similar functions as they do under the create line function. Also included on the edit control menu is a panel at the bottom showing which mouse buttons are active and what there function is at any particular time during the edit session. All of the edit function buttons except for the select line button need a selected line to act upon. If a line has not been selected and one of these buttons is clicked, a panel will pop up with an explanation that a line must be selected before editing can begin.

An edit session begins in select line mode. A line in XMap is actually made up of one or more line segments. Therefore, selecting a line is actually selecting one of the line seg-

ments that makeup a line. If a line segment has already been selected and the user wishes to edit a different segment, the select line button must be clicked.

#### 3.6.2.1 Add Point

The add point function allows the user to add a point to the selected line segment. A point may be added in three different ways: at the beginning, middle, or end of the selected segment. Adding a point at the beginning generates a new line segment between the beginning point of the selected segment and the added point and from the added point to the end of the selected segment. In this case, the original segment is removed. The beginning point for the selected line segment now becomes the added point. A point added at the middle generates a new line segment from the beginning point of the selected line segment to the added point. The beginning point of the selected segment becomes the added point. A point added at the end generates a new line segment from the end point of the selected line segment to the added point. The beginning point for the segment following the selected segment then becomes the added point.

#### 3.6.2.2 Remove Point

The user may remove a point by choosing a point on the selected segment to remove. This is accomplished by clicking the left mouse button near[2] the desired point. Once a point is removed, the line adjusts accordingly.

#### 3.6.2.3 Move Point

A move point function is also provided to modify the shape of a line. To move a point, the user selects a point on the selected line segment in the same way a point was selected for removing a point. Once a point is selected for moving, the middle mouse button is clicked to designate the destination for the point. The line is adjusted accordingly as shown in Figure 4.

#### 3.6.2.4 Move/Erase Line

The move line and erase line functions act on an entire line and not on the selected line segment alone. To move a line, the user selects a reference point and a destination point using the left and middle mouse buttons, respectively. The distances from all points on the line to the reference point are calculated and those values are used with the destination point to reproduce the line at the new location. This procedure, shown in Figure 5, maintains the shape of the line and simply moves it from one location to another. The line at the previous location is then erased. The erase line function simply erases the line from the display and removes its reference from the database maintained by the program.

#### 3.6.2.5 Accept/Cancel

The accept button accepts all of the changes that were affected during the current edit session and returns the user to the main menu. The cancel button disregards any of the changes affected during the edit session, returns the database to its original state before the edit session and redraws the line as it appeared before the edit session began.

2. The program computes the distance from the point clicked and the end points of the selected segment. Whichever distance is smaller, that end point is considered to be the chosen point.

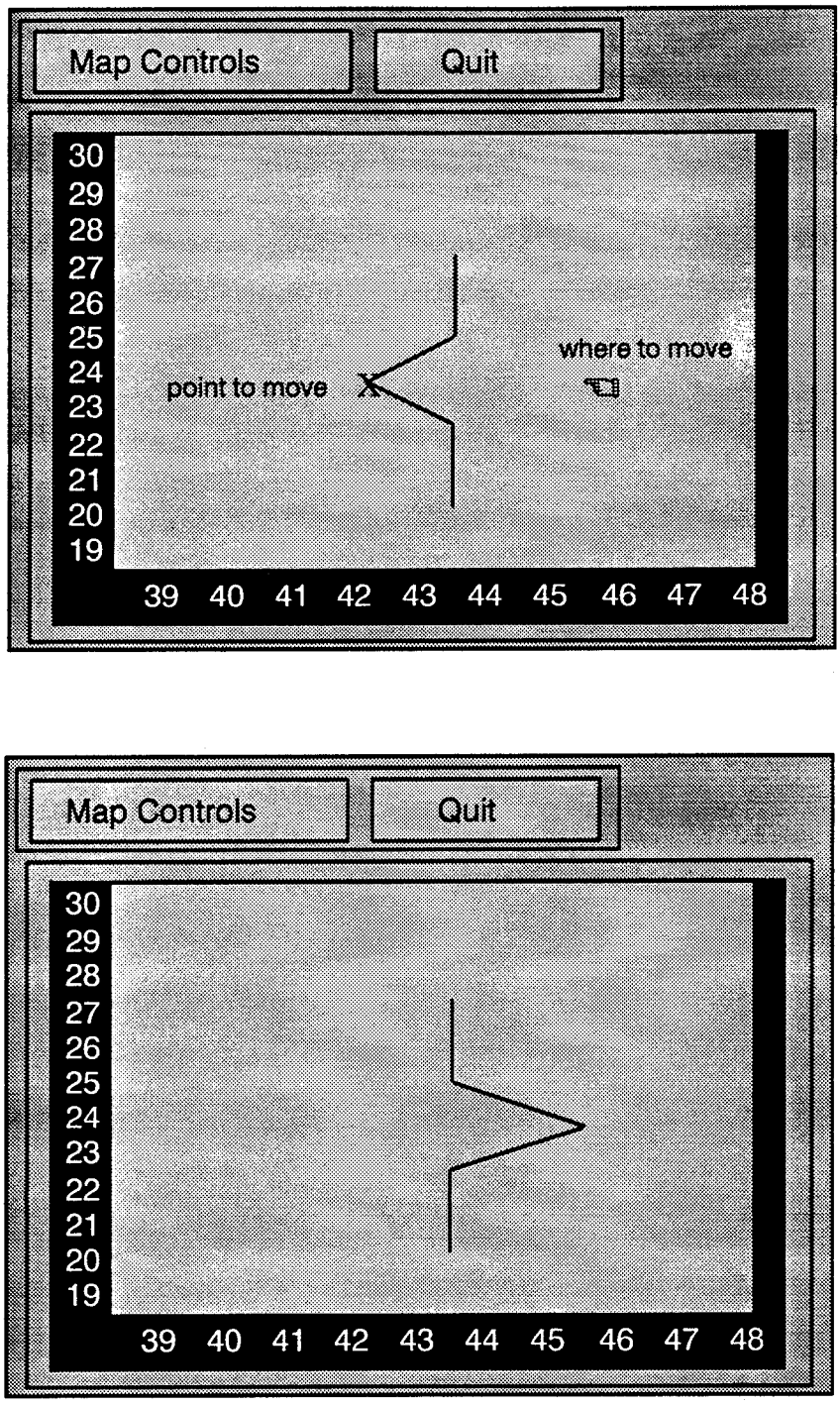


**Figure 4.** Moving a point on a line.

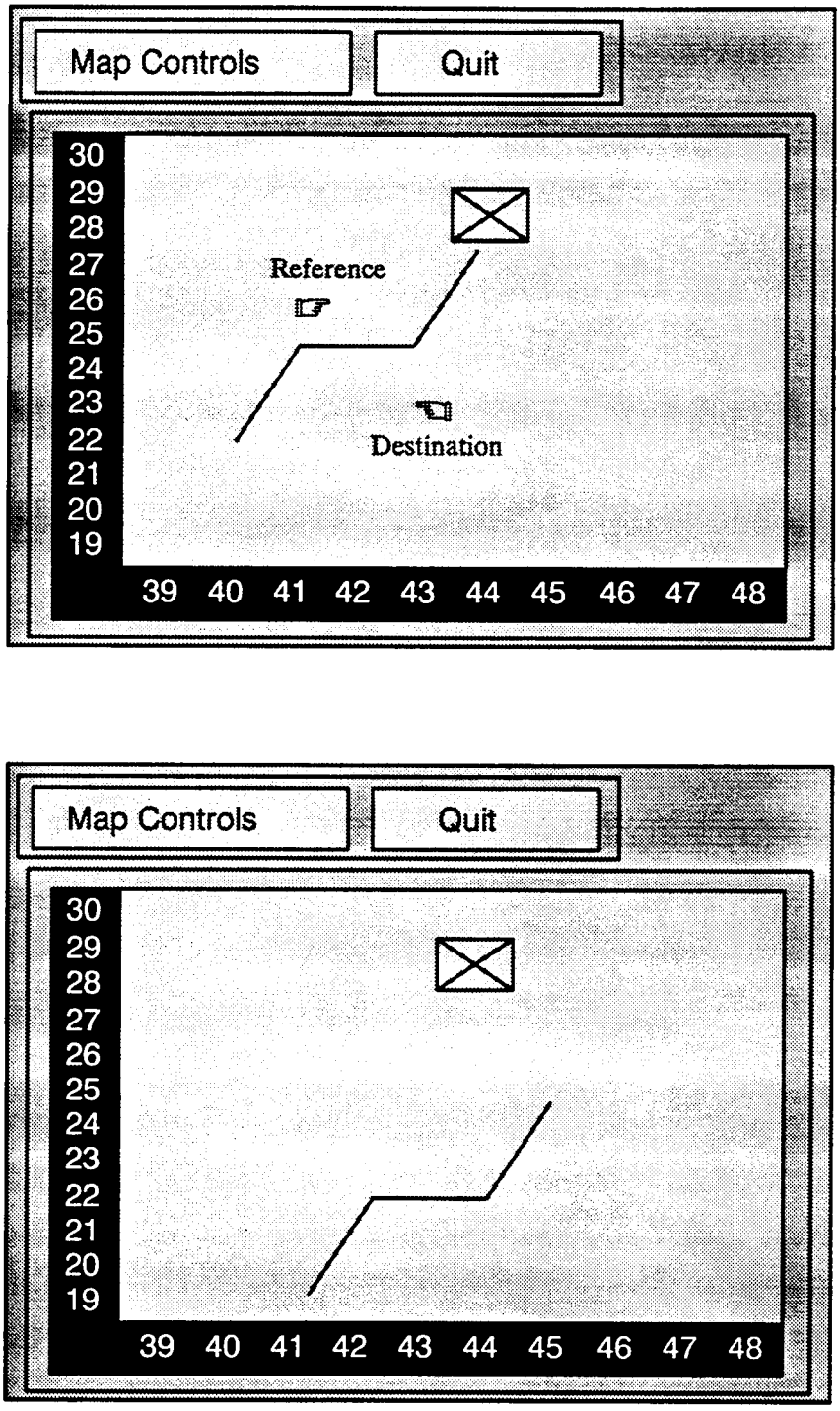


**Figure 5.** Moving a line.

## 4. Summary

XMap is a program that provides a general purpose display area where a digitized map can be displayed and overlaid with objects such as unit symbols, routes, lines, etc. It receives and sends information to specialized application programs via an application interface protocol called LIBXMAP. These application programs interface with the IDT fact base and request XMap to display, select, or remove objects. XMap relieves the application programs of the burden of interfacing with the window environment.

The XMap program, together with associated application programs, demonstrates the IDT concepts of distributing information accurately and timely on a dynamic battlefield. Military commanders will quickly be able to observe the battle as it develops and make informed decisions.

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